

reef formation. The proven presence of reefs in the Tiffin-Carey area strongly supports this conclusion. Cumings and Shrock (1928) came to the conclusion from their detailed study of the Indiana reefs that in Huntington (Racine-Guelph) time "the reefs.....spread like a Great Barrier Reef over the entire sweep of the shallow waters around the Michigan basin, littering its floor with their pure, calcareous sand, and yielding a congenial habitat to vast swarms of giant brachiopods and massive-shelled molluscs." Clarke and Ruedemann (1903) from general considerations of lithology and faunas and from analogy with known reef formations came to a similar conclusion. On page 121 they say, "In New York the Guelph period was still a time of coral reefs, and the distribution of the peculiar fauna, characteristic of this reef in Ontario and Ohio, shows that probably the entire shallow Guelph basin was more or less studded with coral reefs." And again (p. 135) "Over all this amphitheatre, bounded without by the Niagaran, we may conceive of a shallowing sea, dotted with coral banks which must in no small measure have fringed its shore." So from general considerations these distinguished paleontologists anticipated by a quarter of a century the conclusions now demonstrated by detailed studies such as those of the present paper.

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LISTS OF SPECIES FROM THE NEW CORYDON, KOKOMO AND KENNETH FORMATIONS OF INDIANA, AND FROM REEFS IN THE MISSISSINEWA AND LISTON CREEK FORMATIONS

E. R. CUMINGS, Indiana University

1. *The New Corydon dolomite.* In our report on the Silurian rocks of northern Indiana (1928), Dr. Shrock and the writer named and described the New Corydon limestone, from outcrops in Huntington, Adams and Jay counties, Indiana. We also listed a fauna of 13 species—all that had been identified from the formation at that time. These species were mostly well known Lockport corals. The fauna and the lithology of the New Corydon, especially its extremely

cherty character, led us to suppose that the formation represented the final episode of the Niagaran of Indiana.

During the past year two circumstances have thrown considerable additional light on the correlation of the New Corydon. First, the writer has obtained by careful collecting, a considerable list of species in addition to those already known, so that the total is now 33 species. Second, the detailed study of cuttings from two wells in Fort Wayne, drilled by the Fort Wayne water company, has shown that the Huntington formation of northeastern Indiana is 450 feet thick; and that the New Corydon limestone (dolomite) is merely a bed in the middle of the Huntington. These latter facts are reviewed in another paper. At Fort Wayne the New Corydon member is about 100 feet thick.

The species identified from the New Corydon member are as follows, those previously listed being indicated by a star:

- Clathrodictyon fastigiatum* Nicholson—H.
- C. ostiolatum* (Nicholson)—H.
- Stromatopora antiqua* (Nicholson and Murie)—H.
- **Cladopora laqueata* Rominger—K.
- **C. reticulata* Hall—K., H.
- **C. striata* Davis—K.
- **Favosites favosus* (Goldfuss)—K.
- **F. niagarensis* Hall—K., S. & B.
- F. hisingeri* (Edwards and Haine)—H.
- F. hispidus* Rominger—H.
- **Halysites catenularia* (Goldfuss)—H., K., S. & B.
- **H. labyrinthicus* (Goldfuss)—H.
- **Strombodes pentagonus* Goldfuss—K., H.
- **S. striatus* (D'Orbigny)—K., H.
- Cyathophyllum* sp. S. & B.
- Alveolites undosus* Miller—H.
- Alveolites* sp.—H.
- Lyellia americana* Edwards and Haine—H.
- Zaphrentis racinensis* Whitfield—H.
- Syringopora* sp. (cf. *S. fibrata*)—H.
- Diphyphyllum* sp.—H.
- **Conchidium multicostatum* (Hall)—H.
- **Meristina maria* (Hall)—H., K.
- **Pentamerus oblongus* Sowerby (A small nontypical form)—K. S. & B.
- Atrypa reticularis* (Linnaeus)—S. & B.
- Leptaena rhomboidalis* (Wilckens)—K., S. & B.
- Whitfieldella* sp.—K., S. & B.
- Camarotoechia* sp.—S. & B.
- Coelocaulus bivittatus* (Hall)—H.
- Liospira perlata* (Hall)—H.
- Poleumita* sp. (A rather large form like *P. sp. indt.* of Kindle 1904)—H.
- Dawsonoceras annulatum* (Sowerby)—H.
- Odontopleura* sp. (A very poor fragment)—H.

H., Huntington; K., J. W. Karsch quarry; S. & B., Smith and Baker quarry.

Clathrodictyon fastigiatum and *C. ostiolatum* are typical Guelph species. So also are *Coelocaulus bivittatus* and *Liospira perlata* and the undetermined species

of *Poleumita*. *Favosites hispidus*, *Halysites labyrinthicus*, *Zaphrentis racinensis* and *Diphyphyllum* favor the Guelph. The others are noncommittal. The species listed as *Strombodes striatus* is probably *S. pentagonus*, which is common at Huntington, and is a well known Racine species. There is nothing in this fauna to indicate that the New Corydon is anything other than a local cherty development of the Huntington; and with the evidence of the Fort Wayne wells this conclusion may be accepted as valid.

2. *The Kokomo limestone*. Prior to the studies of Cumings and Shrock (1928, 1928a) seven species of fossils, mostly Eurypterids, had been reported from unequivocal Kokomo limestone. The collecting of the past year has added 20 species to this meager list. Several of these are new, and will be described and figured in a later paper. Most of the species heretofore reported from the Kokomo are confined to the overlying Kenneth limestone; but several species supposed to be from the Kenneth are restricted to the Kokomo. One of the results of the writer's detailed collecting has been to more clearly differentiate the Kokomo and Kenneth faunas. They are in fact strikingly distinct.

Following is the complete list of the species of the Kokomo limestone. Species previously reported are starred.

- Halysites labyrinthicus* (Goldfuss)—L.
- Cyathophyllum hydraulicum* Simpson—L. (Rather larger and of more irregular growth than the typical form).
- Cyathophyllum* sp. (Possibly an *Amplexus*)—L.
- Stromatoporoid* (Not generically identifiable)—L.
- Conchidium* n. sp. (Near *C. nysius*)—L.
- Conchidium* n. sp.—L.
- Conchidium* sp. (cf. *C. laqueatum*)—L.
- **Pentamerus divergens* Foerste—K. L.
- Pentamerus* sp.—L.
- **Spirifer corallinensis* (Grabau)—L.
- Schuchertella interstriata* (Hall)—L.
- Atrypa reticularis* (Linnaeus)—L.
- Reticularia* n. sp.—L.
- Dalmanella parva* n. sp.—L.
- Dalmanella* n. sp. (A larger form)—L.
- Leperditia ohioensis* Bassler L.
- Leperditia* sp. (Smaller and probably distinct)—L.
- Conocardium* sp.—L.
- Buthotrephis* sp.—L.
- A *Ceratiocarid*—L.
- **Anomalocaris* (?) *kokomoensis* Ruedemann—K.
- **Buthotrephis divaricata* David White—K.
- **B. newlini* D. White—K.
- **Eurypterus* (*Onychopterus*) *kokomoensis* Miller and Gurley—K.
- **E. ranilarva* Clarke and Ruedemann—K.
- **Eusarcus newlini* (Claypole)—K.
- **Stylonurus* (*Drepanopterus*) *longicaudatus* Clarke and Ruedemann—K.

L., Logansport; K., Kokomo.

This is an extremely interesting fauna, and completely confirms the long suspected correlation of the Kokomo limestone with the Bertie-Akron of New

York and Ontario. The presence of *Cyathophyllum hydraulicum* and *Schuchertella interstriata* is especially significant. These come from a rather massive brown dolomite in the upper half of the formation at the quarry east of Logansport. The long, contorted, slender coralla of the *Cyathophyllum* are exceedingly abundant at this locality. *Leproditia* (the smaller form for the most part) is also very abundant east of Logansport; but the typical *ohioensis* occurs very commonly about midway of the formation at the abandoned Blue Hole quarry west of Logansport. The specimens are very perfect and of large size. No bioherms of stromatoporoids, such as characterize the equivalent Greenfield dolomite in Ohio, have been found in the Indiana region. Across the Wabash river from the County Club, east of Logansport, however, a beautiful bioherm of *Halysites* is exposed in the river bank. The coral fills the rock.

The term *bioherm*, recently proposed by Cumings and Shrock (1928a), is here preferred to the much abused term reef; and is defined as consisting of *any dome-like, mound-like, lense-like or otherwise circumscribed mass, built exclusively or mainly by sedentary organisms such as corals, stromatoporoids, algae, brachiopods, molluscs, crinoids etc., and enclosed in normal rock of different lithologic character*. The word comes from two Greek words meaning *organic*, and *reef* or *mound*.

3. *The Kenneth limestone*. Cumings and Shrock (1928) listed 21 species from the Kenneth limestone of Indiana. The present writer finds that three of these, *Pentamerus divergens*, *P. pesovis* (probably) and *Spirifer corallinensis*, are confined to the Kokomo limestone. *Spirifer exiguus* has not been found by the writer in either the Kokomo or the Kenneth limestones. It may quite certainly be excluded from the Kenneth. The collecting of the past year has added several interesting species to the list.

Below is a complete list of the species of the Kenneth limestone:

Amplexus septatus Foerste—K., L.

Cladopora sp.—L.

Favosites pyriformis kokomoensis Foerste—K.

Favosites sp.—L.

Cyathophyllum sp.—L. (A slender cylindrical form).

Halysites catenularia (Linnaeus)—K., L.

Chonetes colliculus Foerste—K., L.

Chonetes sp.—K., P.

Conchidium colletti (Miller)—K., L.

Coelospira congregata (Kindle and Breger)—K., L.

Dalmanella elegantula (Dalman)—K., L. (This is a small species, and probably is distinct from *D. elegantula*).

Dalmanella n. sp.—L. (A small form with high carinate ventral valve like *D. postelegantula* of the Decker Ferry formation).

Gypidula n. sp. (A smooth form very much like Weller's *Pentamerus circularis*, which is probably a *Gypidula*; and like the Keyser *Gypidulas*)—L., K.

Gypidula n. sp. (Small plicated form)—L., K.

Leptaena rhomboidalis (Wilckens)—L., K. (Small, with few rugae).

Atrypa calvini Nettleroth (var.)—K.

Uncinulus stricklandi var.—K.

Rhynchospira cf. *globosa* (Hall)—K.

Rhynchotretra cuneata (Hall)—K. (A poorly preserved specimen doubtfully referred to this species).

Strophonella sp.—K.

Scenidium n. sp.—L. (Plications as in the Lower Helderberg species).

Whitfieldella erecta Foerste—K. (May be a *Hindella*).

Hindella sp.—L. (A very minute species similar to *H. congregata* of the Keyser).

Wilsonia kokomoensis (Miller)—K., L.

Isochilina musculosa Foerste—K.

Kloedenia kokomoensis Foerste—K.

Dizygopleura cf. *clarkei paupera* Ulrich and Bassler (Very close to that species)—L.

Orthoceras sp.—K.

Cystid plate, very close to *Pseudocrinites gordonii* Schuchert.

L., Logansport; K., Kokomo; P., Pipe Creek Falls.

The fauna of the Kenneth is intensely interesting. It is unlike anything else in the Michigan Basin region; but very suggestive of the Decker Ferry-Keyser fauna of New Jersey, Pennsylvania and Maryland. *Coelospira congregata*, which is the commonest species, and is often extremely abundant, is nearly identical with *C. concava tonolowayensis* Swartz of the Keyser. The next most abundant species, *Gypidula* n. sp. (Smooth form), is very similar to the Keyser *Gypidulas* and to *Pentamerus circularis* Weller, which is probably a *Gypidula*, from the Decker Ferry formation. The small carinate *Dalmanella* from the Kenneth is close to the *Dalmanellas* of the Keyser. Foerste's *Favosites pyriformis kokomoensis* is no other species of suggestive relations. His *Whitfieldella erecta* may very likely be a *Hindella*; but in the absence of the internal structure this point cannot be settled. A very minute *Hindella* quite certainly occurs in the Kenneth. *Rhynchospira globosa*, though somewhat doubtfully identified, is another Keyser form. *Chonetes colliculus* may be closely related to *C. jerseyensis* of the Keyser. It is very abundant in the Kenneth. The cystid plate and the little *Dizygopleura* are significant. If these species indicate the correlation of the Kenneth limestone of Indiana with the Keyser and Decker Ferry formations, it would be interesting to know by what route they migrated between the two widely separated localities. There is no correlative of the Kenneth in the Monroan of Michigan, nor so far as known, in the rocks of Ohio.

4. *Liston Creek reef at Lapel*. At the time of the publication of the Silurian rocks of Northern Indiana (Cumings and Shrock, 1928) no exhaustive collections had been made from unequivocal Liston Creek and Mississinewa reefs, and especially from the latter. The opening of a quarry and drainage ditch in an extensive reef flank north of Lapel, Indiana, and the belated discovery of an excavation in the flank of a Mississinewa reef along the drainage canal in section 20, T. 27 N., R. 4 E., northwest of Peru, Indiana, furnished an opportunity to make such collections. Several species of great value in correlation are included in these collections.

The fauna of the Liston Creek reef north of Lapel is as follows:

Amplexus sp.

Alveolites louisvillensis Davis.

Alveolites sp.

Cladopora n. sp. (Very slender stems and few rows of corallites).

- Cladopora* sp.
Cyathophyllum cf. *radicula* Rominger
Favosites favosus (Goldfuss).
F. hisingeri (Edwards and Haime).
F. niagarensis Hall.
Halysites catenularia (Linnaeus).
H. labyrinthicus (Goldfuss).
Heliolites elegans Hall.
Pycnostylus elegans Whiteaves (?).
Thecia minor Rominger.
Zaphrentis stokesi Edwards and Haime.
Zaphrentis sp. (Slender with very irregular growth).
Receptaculites sp. (Coarser structure than *R. hemisphericus*).
Clathrodictyon sp.
Stromatopora antiqua (Nicholson and Murie).
Pisocrinus sp.
Two other species of crinoids, not identifiable.
Atrypa calvini Nettleroth.
A. reticularis (Linnaeus).
Camarotoechia sp.
Conchidium laqueatum (Conrad).
C. littoni (Hall).
C. multicostatum (Hall).
C. nysius (Hall and Whitfield).
Cyrtia myrtia (Billings).
Dalmanella elegantula (Dalman).
Leptaena rhomboidalis (Wilckens).
Meristina maria (Hall) (Very large individuals).
Pentamerus sp.
Orthis flabellites Foerste (As figured by Kindle. Probably a distinct species).
Reticularia bicostata petita (Hall).
Spirifer foggi Nettleroth.
S. nobilis (Barrande).
S. crispus (Hisinger).
Strophonella semifasciata (Hall).
Stricklandinia sp.
Schuchertella subplana (Conrad).
Whitfieldella nitida (Hall).
W. cf. marylandica Prouty.
Fenestella sp.
Pleumita sp.
Actinoceras sp. (Siphuncle).
Kionoceras cancellatum (Hall).
Kionoceras sp. (Longitudinally ribbed like *K. angulatum* as figured by Grabau, Index Fossils).
Bumastus ioxus (Hall).
Calymene niagarensis Hall.
Calymene cf. *vogdesi* Foerste.
Enerinurus indianensis Kindle and Breger.
Iliaenus sp. (cf. *insignis*).

Of these species, *Alveolites louisvillensis*, *Cyathophyllum radícula*, *Zaphrentis stokesi*, *Conchidium littoni*, *C. nysius*, *Reticularia bicoslata petila*, *Strophonella semifasciata*, *Whitfieldella* cf. *marylandica*, *Actinoceras* sp., and *Kionoceras* aff. *angulatum* are new additions to the Liston Creek fauna. *Thecia minor* has not heretofore been found in reef rock. Several of the above species are especially indicative of the correlation of the Liston Creek formation with the Louisville formation. Such are, *Alveolites louisvillensis*, *Zaphrentis stokesi*, *Conchidium littoni*, and *C. nysius*. To the numerous Louisville species already known from the Liston Creek formation may also be added *Romingeria vannula* Davis, recently collected from typical Liston Creek cherty limestone at Huntington, and *Lyellia americana* from the Liston Creek reef at Markle. The single specimen of *R. vannula* is beautifully preserved and absolutely typical. The correlation of the Liston Creek limestone with the Louisville can, therefore, no longer be regarded as doubtful.

5. *Mississinewa reef northwest of Peru.* After most of our 1928 paper was in manuscript, Dr. Shrock discovered an isolated excavation through the flank of a reef in the Mississinewa shale, along the drainage canal through the level valley land in section 20, northwest of Peru. The outcrop is briefly described on page 159 of our report (1928). The canal at this point cuts through the flank of a reef, and large piles of the reef rock have been thrown out on either side of the canal just east of a farm bridge across the canal. For some distance east along the canal the excavation is in typical Mississinewa shale. Four hundred feet west of this outcrop the canal is excavated through typical Kokomo limestone, much contorted and brecciated. It appears likely that the extreme brecciation and contortion of certain layers in the Kokomo may be due to submarine solifluction on the slopes of these buried Mississinewa reefs. Low klintar rise a few feet above the valley floor, both to the north and south of the drainage ditch. Dr. Shrock has found several other small outcrops of reef rock in the level valley land west of Peru. These prick through the Kokomo limestone which outcrops at several points in the valley. (See Cumings and Shrock, 1928, pp. 128-129 and 159-160). Evidently a very large number of reefs lie buried beneath the Kokomo limestone of Indiana.

The fauna of this reef flank in the drainage canal is as follows:

- Fenestella cf. *elegans* Hall.
- Fenestella sp.
- Fistulipora *neglecta maculata* Hall (?)
- Chilotrypa *ostiolata* (Hall).
- Polypora cf. *punctostriata* (Hall).
- Polypora sp.
- Pseudohornera *niagarensis* (Hall).
- Semicosciniium sp. (Near *acmeum*).
- Spatiopora *maculata* (Hall).
- Trematopora sp.
- Pinnatopora sp.
- Atrypa *reticularis* (Linnaeus).
- Anastrophia *internascens* Hall.
- Camarotoechia *indianensis* (Hall).
- C. *neglecta* (Hall).
- C. *whitei* (Hall).

Leptaena rhomboidalis (Wilekens).
Spirifer crispus (Hisinger).
S. crispus simplex (Hall).
Schuchertella subplana (Conrad).
Stropheodonta sp.
Strophonella semifasciata (Hall).
Pentamerus n. sp.
Trematospira cf. *camura* Hall.
Strophonella striata (Hall).
Rhipidomella hybrida (Sowerby).
Whitfieldella nitida (Hall).
Wilsonia n. sp. (Near *W. saffordi*, but more nearly spherical).
Pterinea emacerata (Conrad).
Leiopetelia subplana (Hall).
Dawsonoceras annulatum (Sowerby) (Longitudinal ribs like *D. granti* Foerste).
D. americanum (Foerd).
Discoceras cf. *marshi* (Hall) (Annulations rather closer and less oblique).
Kionoceras cancellatum (Hall).
Encrinurus indianensis Kindle and Breger.
Bumastus ioxus (Hall).
Illaenus sp.
Pisocrinus campana Miller (Arms of calyx).
Crinoid sp.

The fossils of this reef rock, which is strongly dolomitized and very porous, are mostly very poorly preserved. This applies especially to the Bryozoa, which are extremely abundant. The zooecia of the Fenestellids were not clearly seen in any specimen, so that identifications are based on the general appearance and proportions of the very numerous zoaria. Among the brachiopods *Leptaena rhomboidalis* is far and away the most abundant, being extremely common. The two pelecypods are identified with some hesitation; but are at least very close to the species indicated. The presence of *Pisocrinus*, heretofore reported only from the Liston Creek limestone in northern Indiana, is very interesting, and indicates along with much other evidence that that genus and its associates belong in very early Lockport and pre-Lockport. The general cast of this fauna is Rochester; and is in line with the indications of the extensive graptolite fauna described by Shrock (1928). It is interesting that this reef is mainly composed of bryozoan remains.

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